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GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: WM **Project:** Maplewood XL **Project/Proposal #:** ME0169 **Task #:** 05

TITLE OF COMPUTATIONS SLOPE STABILITY OF BIOREACTOR AREA

COMPUTATIONS BY:	Signature Douglas T. Mandeville Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer	01/15/01 DATE
ASSUMPTIONS AND PROCEDURES CHECKED BY: (Peer Reviewer)	Signature FOR Printed Name and Title: William M. Steier, Senior Staff Engineer	1/15/01 DATE
COMPUTATIONS CHECKED BY:	Signature FOR Printed Name and Title: William M. Steier, Senior Staff Engineer	1/15/01 DATE
COMPUTATIONS BACKCHECKED BY: (Originator)	Signature Douglas T. Mandeville Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer	01/15/01 DATE
APPROVED BY: (PM or Designate)	Signature M F Houlihan Printed Name and Title: Michael F. Houlihan, P.E., Principal	1/15/01 DATE

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by:	Doug Mandeville	Date:	1/15/01	Reviewed by:	Bill Steier	Date:	1/15/01
Client:	WM	Project:	Maplewood XL	Proj./Proposal No.:	ME0169	Task No.:	05

SLOPE STABILITY OF BIOREACTOR AREA

PURPOSE

The purpose of this calculation is to evaluate the slope stability of the bioreactor configuration of the Maplewood landfill. This bioreactor program is being operated under the EPA's XL program. To get the landfill to operate as a bioreactor, a significant amount of water needs to be added to the waste mass. This water will be added through the use of gravity fed trenches. The addition of water to the waste mass is expected to increase the weight of the mass as well as the pore pressures in the waste mass. This calculation examines the stability of the existing slope with the addition of the water.

The slope stability analysis is performed to verify that the idealized configuration has an adequate factor of safety against failure under static loading conditions. According to technical manual published by the USEPA entitled "Solid Waste Disposal Facility Criteria" [USEPA, 1993], the minimum recommended factor of safety against slope stability failure for permanent conditions is 1.5. The current standard of practice when examining pseudo-static conditions is to evaluate the displacement along the slip surface; a displacement of less than 1 foot is considered to be satisfactory [Seed and Bonaparte, 1992].

SELECTION OF CRITICAL CROSS SECTION

Figure 1 shows the area in which liquid will be added to the landfill. In examining this Figure, a potential critical section exists at each of the outward facing slopes. The north and west facing slopes have a perimeter berm located at the limit of waste. The south facing slope is buttressed by the existing waste mass located in Phase 3. The east facing slope is not buttressed by a perimeter berm or adjacent waste cells and is therefore selected as the critical cross section. Figure 2 is an idealized representation of the critical cross section.

The liquid application trenches to be used in the bioreactor operations are modelled as a 4 foot thick layer of stone with a phreatic surface located at the top of the liquid application trench. The phreatic surface is assumed to have sideslopes of 1 horizontal to 1 vertical; the waste located under and adjacent to the liquid application trench is influenced by this phreatic surface. The liquid application trench will be located at least 50 feet from any outward facing slopes and will be located at least 2 feet under the surface of the landfill.

METHODS OF ANALYSES

The stability factor of safety of the typical cross section is analyzed using limit equilibrium theory along with the methods of slices. The computer program XSTABL [Sharma, 1996] was used to perform the analysis. The procedure consisted of analyzing numerous potential failure surfaces to find the critical failure surface that results in the minimum factor of safety for the slope.

For the slope stability case analyzed in this calculation, a circular slip surface is evaluated using Janbu's method. In this analysis, the slip surface is allowed to pass through the underlying soil. A simplified seismic loading analyses (i.e. pseudo-static slope stability analysis) is also performed for the cross section. The pseudo-static analysis method assumes that the entire soil mass is subjected to the maximum horizontal acceleration (MHA) for the site and assumes that there are no soil amplification effects (the MHA in the bedrock is the same as the MHA in the landfill foundation soil). The MHA is defined as the acceleration with a 90 percent probability of not being exceeded in 250 years. The MHA in bedrock for the Maplewood site is estimated to be 0.23 g, as indicated in Figure 3 [Algermissen et. al., 1990].

The method used to estimate the displacement along the slip surface was obtained from published literature [Makdisi and Seed, 1978]. This method involves calculating the horizontal acceleration that results in a factor of safety of 1; this is referred to as the yield acceleration. The ratio between the yield acceleration and the maximum acceleration (found using Figure 4) is used in conjunction with a design chart to estimate the displacement along the slip surface.

MATERIAL PROPERTIES AND ASSUMPTIONS

The soil material and interface properties used in the slope stability analysis are summarized in the Table 1. These parameters are similar to those used in the original permit application [Donohue, 1991]. The waste properties are based on bi-linear failure envelope [Kavazanjian et al, 1995]. In this failure envelope, the waste has a cohesion value of 500 psf up to a normal stress of 770 psf, above a normal stress of 770 psf, the waste has a friction angle of 33°.

Written by: Doug Mandeville Date: 1/15/01 Reviewed by: Bill Steier Date: 1/15/01

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Table 1. Material properties used in liner slope stability analyses.

Material	Unit Weight(lb/ft^3)	Cohesion (psf)	Friction Angle
Cover soil	130	500	15°
Waste (1)	80	500	33°
Critical liner interface (2)	125	0	10°
Foundation soil	110	950	25°
Trench gravel	120	0	30°
Water	62.4	NA	NA

(1) bi-linear failure envelope based on Kavazanjian et al 1995
(2) 60-mil thick textured HDPE Geocomposite Drainage Layer/prepared subbase.

RESULTS OF ANALYSES

Slope stability analyses were performed for the cross section shown in Figure 1. Table 2 provides a summary of the factors of safety that were obtained in this analysis.

Table 2 - Results of liner stability analyses

	Factor of Safety
	Janbu – Static (Attachment A)
Existing conditions	1.62 (phase2)
With liquid application trench	1.62 (phase2p)

Based on the static analysis conducted for the interim slopes, the computed factor of safety is 1.62, which is greater than the minimum value of 1.5 recommended by the USEPA [1993]. This is the same factor of safety as for the case where leachate is not recirculated. The reason that the factors of safety are the same for both of these cases is that the critical failure surface for both cases is located outside the anticipated zone that would be wetted by liquid application during recirculation events. Therefore, the addition of liquid does not change the location of the critical surface and the factor of safety remains the same as for existing conditions.

The displacement along the slip surface of the landfill is estimated for the critical pseudo-static case presented above. To find the displacement along the slip surface of the landfill, the horizontal acceleration that produces a factor of safety of 1 is calculated through a trial and error approach using XSTABL. The XSTABL output for that resulted in a factor of safety equal to 1 is provided in Attachment C (filename phase2p1). A horizontal acceleration of 0.20 g results in a factor of safety equal to 1.0. This is referred to as the yield acceleration. The ratio between the yield acceleration and the maximum acceleration is used in with Figure 4 to evaluate the displacement of the landfill. From Figure 4, when the ratio between the yield and maximum acceleration is 0.9, the maximum displacement of the landfill (corresponding to a magnitude 8.25 earthquake) is 0.254 inches. This is less than the recommended value of 12 inches [USEPA 1995]; therefore, the landfill design is satisfactory.

Written by: Doug Mandeville	Date: 1/15/01	Reviewed by: Bill Steier	Date: 1/15/01
Client: WM	Project: Maplewood XL	Proj./Proposal No.: ME0169	Task No.: 05

REFERENCES

Algermissen, S., Perkins, D., Thenhaus, P., Hanson, S., and Bender, B., "*Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico*", U.S. Geological Survey, Miscellaneous Field Studies Map MF-2120, 1990.

Donohue Engineers, Architects, Scientists, Permit Application for Maplewood Landfill, 1991

Kavazanjian Jr., E., Matasovic, N., Bonaparte, R., and Schmertmann, G., "Evaluation of MSW Properties for Seismic Analysis", *Proceedings, Geoenvironment 2000, Vol II*, New Orleans, LA, Feb 1995, pp. 1126-1141.

Makdisi, F.I., and Seed, H.B., "Simplified Procedure for Estimating Dam and Embankment Earthquake Induced Deformations," ASCE Journal of Geotechnical Engineering, Vol. 104, No. GT7, July 1978, pp. 849-867.

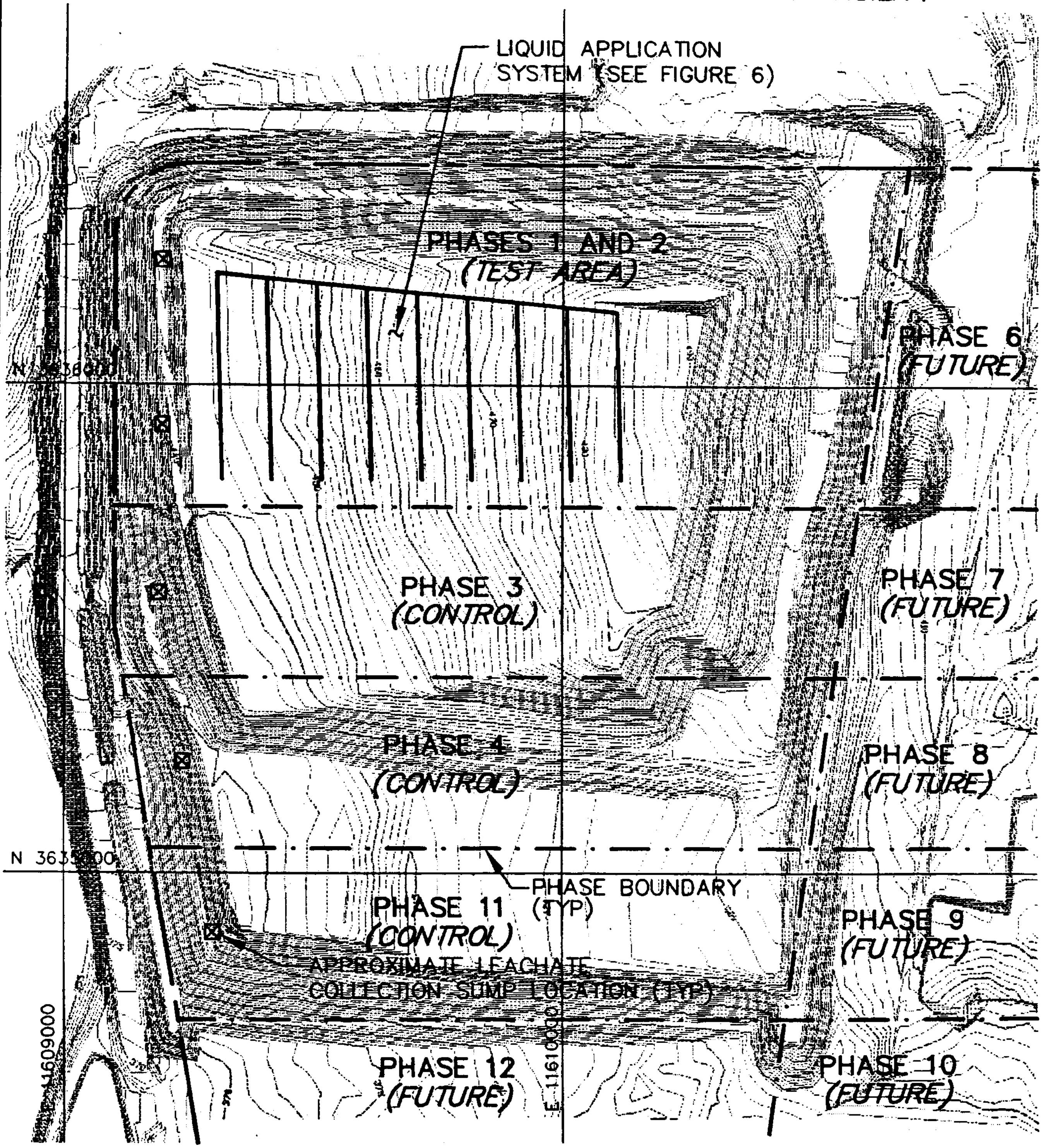
Seed, R.B., and Bonaparte, R., "Seismic Analysis and Design of Lined Waste Fills: Current Practice," Proc. Stability and Performance of Slopes and Embankments – II, Vol. 2, ASCE Geotechnical Special Publication No. 31, Berkeley, California, pp. 1521-1545.

Sharma, S. "XSTABL: an integrated Slope Stability Program for Personal Computers", Version 5.201, Interactive Software Designs, Inc., Moscow, ID, 1996.

United States Environmental Protection Agency, "Solid Waste Disposal Facility Criteria", Document No. EPA 530-R-93-017, November 1993.

United States Environmental Protection Agency, "RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities," April 1995.

BIOREACTOR SYSTEM LAYOUT
MAPLEWOOD RECYCLING AND WASTE DISPOSAL FACILITY



NOTES:

1. SURVEY BY FLORA SURVEYING ASSOCIATES, INC., DATED OCTOBER 1999.
2. PHASES 3, 4 AND 11 ARE CONTROL CELLS.

300 150 0 300

SCALE IN FEET

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COLUMBIA, MARYLAND

FIGURE NO.	1
PROJECT NO.	ME0169
DOCUMENT NO.	
FILE NO.	0169P102

GeoSyntec Consultants

Page 1 of ____

Written by: Doug Mandeville Date: 00/10/09 (YY/MM/DD) Reviewed by: ____ Date: __/__/__ (YY/MM/DD)

Client: Waste Management Project: Maplewood Permit Amendment Project/Proposal No.: ME0169 Task No.: 05

cross section 9000 N

used bi-linear with c=500 and φ=25° for foundation

Material	Cohesion	Friction angle	γ_{sat}
1 Final cover	500 lbs/ft²	15°	130 lbs/ft³
2 Waste	100 lbs/ft²	25°	60 lbs/ft³
3 Base cover (liner)	0 lbs/ft²	10°	125 lbs/ft³
4 foundation soil	950 lbs/ft²	25°	110 lbs/ft³

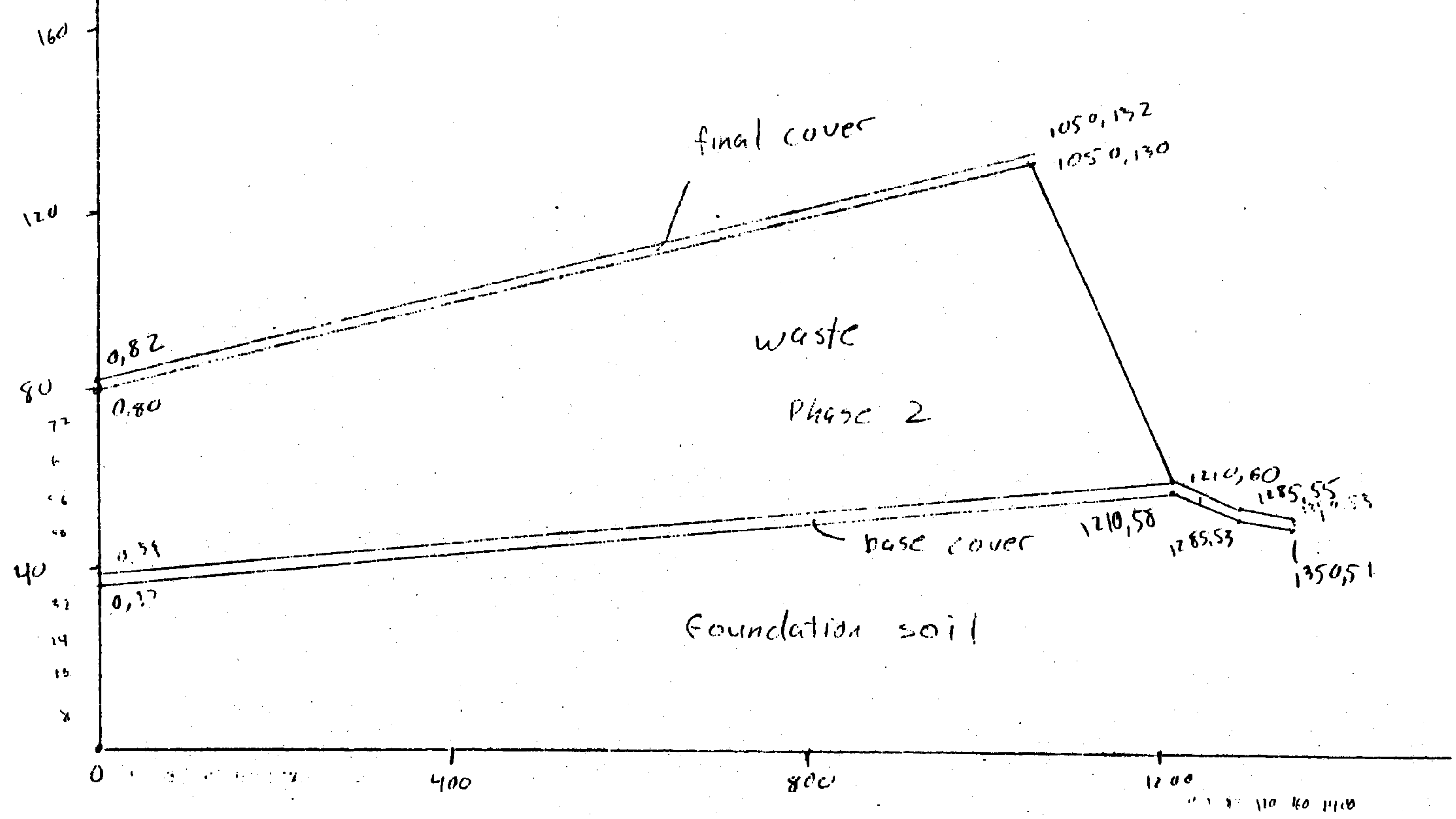
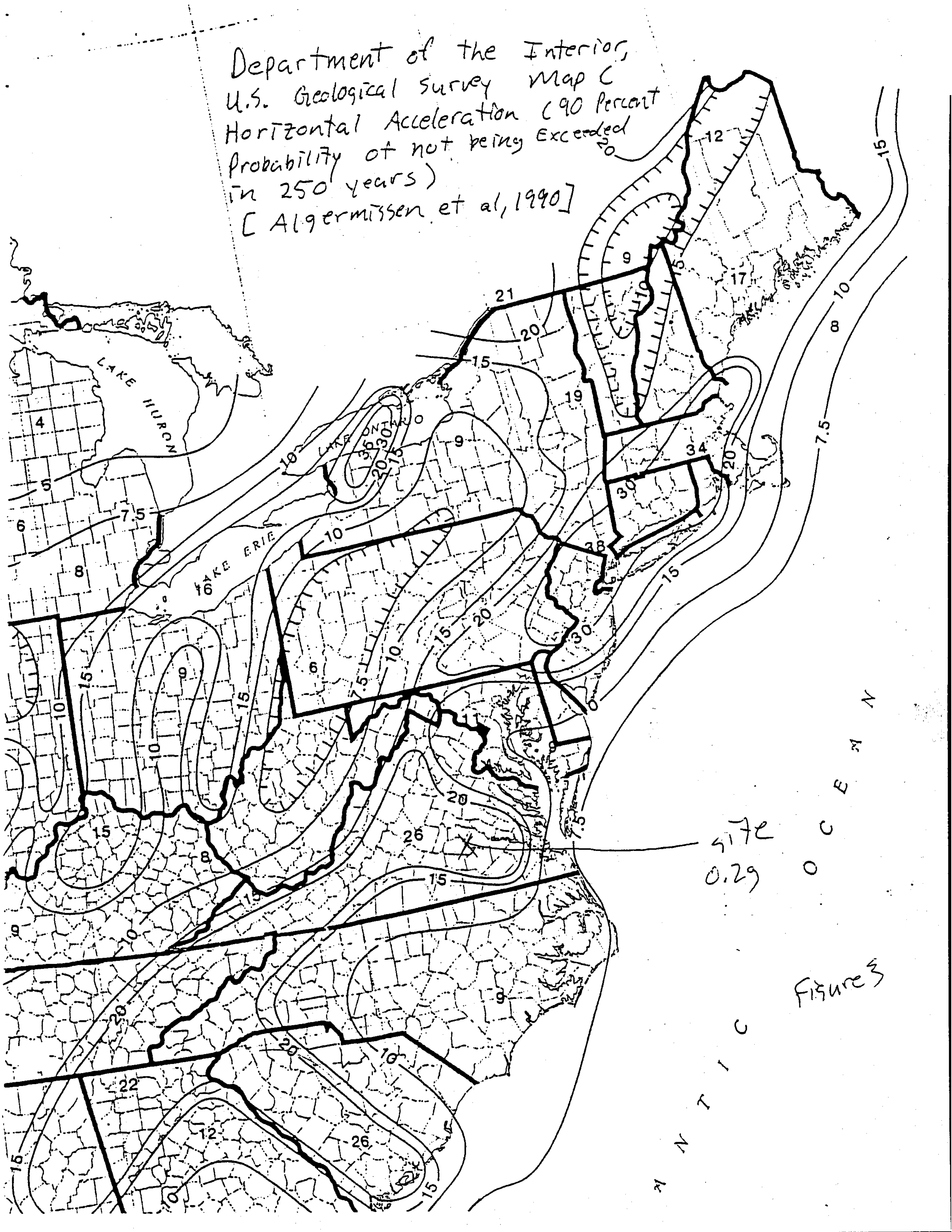


Figure 2


Department of the Interior, U.S. Geological Survey Map C Horizontal Acceleration (90 Percent Probability of not being Exceeded in 250 years)
[Algermissen et al, 1990]
LAKE HURON
LAKE ONTARIO
LAKE ERIE
ANTIC OCEAN
site 0.29
Figure 3

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Page ____ of ____

Written by: D. Mandeville Date: 01/01/15 Reviewed by: ________ Date: __/__/__

Client: WM Project: XL - Maplewood Project/Proposal No.: ME0169 Task No.: 05

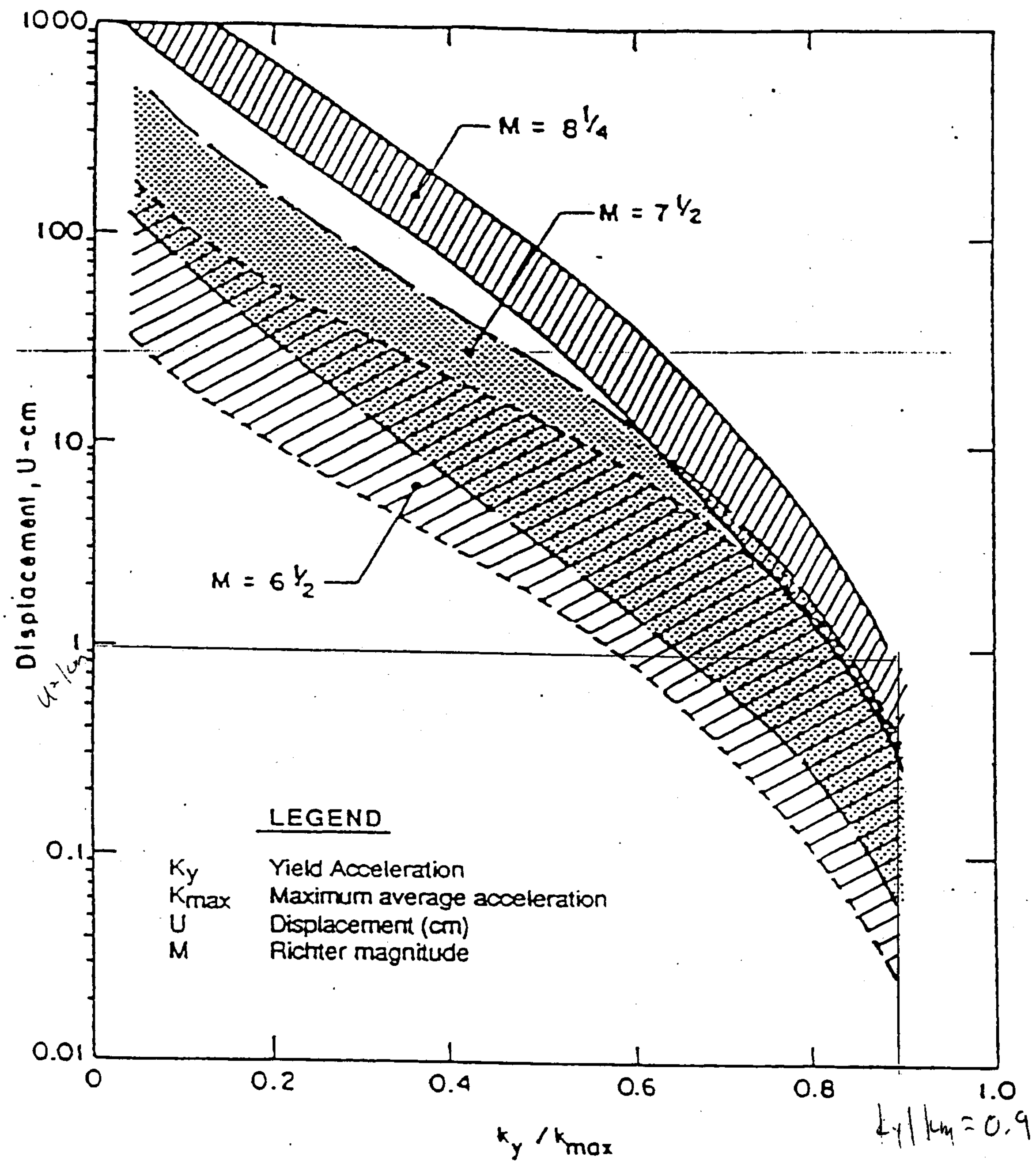


Figure 4

Ref: Makdisi, F. I., and Seed, H. B. (1978), "Simplified Procedure for Estimating Dam and Embankment Earthquake Induced Deformations," Journal of Geotechnical Engineering ...

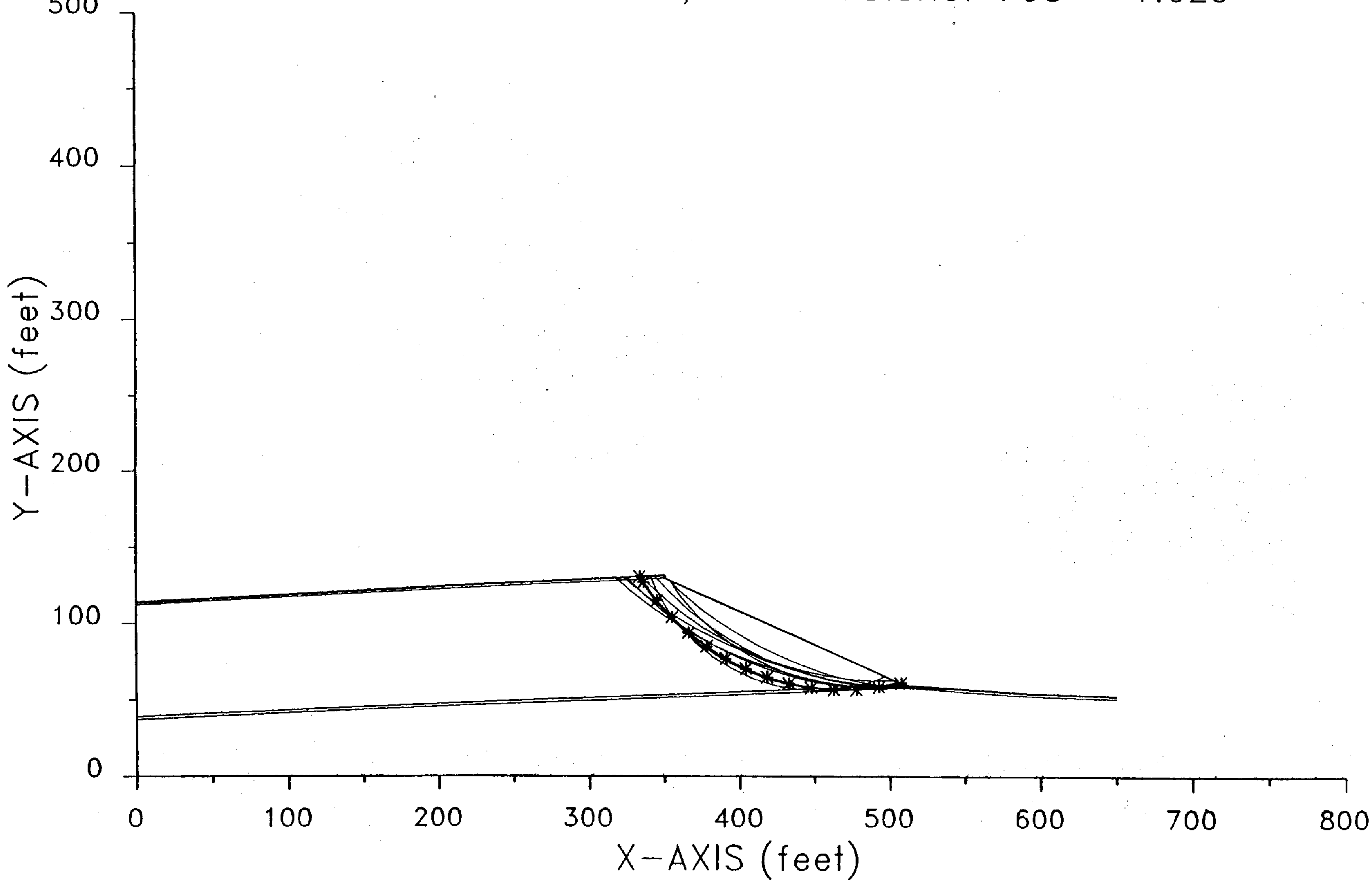
Written by:	Doug Mandeville	Date:	1/15/01	Reviewed by:	Bill Steier	Date:	1/15/01
Client:	WM	Project:	Maplewood XL	Proj./Proposal No.:	ME0169	Task No.:	05

ATTACHMENT A

PHAS_ 1-15-** 14:51

Maplewood Bioreactor Phase 2

10 most critical surfaces, MINIMUM BISHOP FOS = 1.620



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*               using the                   *
*            Method of Slices               *
*                                           *
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* Ver. 5.202                   96 - 1305    *
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Problem Description : Maplewood Bioreactor Phase 2

SEGMENT BOUNDARY COORDINATES

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	114.0	350.0	132.0	1
2	350.0	132.0	350.1	130.0	1
3	350.1	130.0	510.0	60.0	1
4	510.0	60.0	585.0	55.0	1
5	585.0	55.0	650.0	53.0	1

8 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	112.5	350.0	130.0	2
2	350.0	130.0	510.0	60.0	2
3	.0	39.0	510.0	60.0	3
4	510.0	60.0	585.0	55.0	3
5	585.0	55.0	650.0	53.0	3
6	.0	37.0	510.0	58.0	4
7	510.0	58.0	585.0	53.0	4
8	585.0	53.0	650.0	51.0	4

ISOTROPIC Soil Parameters

5 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	130.0	130.0	500.0	15.00	.000	.0	0
2	80.0	80.0	.0	.00	.000	.0	0
3	125.0	125.0	.0	10.00	.000	.0	0
4	110.0	110.0	950.0	25.00	.000	.0	0
5	80.0	80.0	.0	.00	.000	720.0	0

NON-LINEAR MOHR-COULOMB envelope has been specified for 1 soil(s)

Soil Unit # 2

Point No.	Normal Stress (psf)	Shear Stress (psf)
1	.0	500.0
2	770.0	500.0
3	25000.0	16235.0

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

10 Surfaces initiate from each of 100 points equally spaced along the ground surface between x = 400.0 ft and x = 600.0 ft

Each surface terminates between x = 300.0 ft and x = 375.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

```
**********************************************************************
  -- WARNING -- WARNING -- WARNING -- WARNING -- (# 48)
**********************************************************************
```

Negative effective stresses were calculated at the base of a slice. This warning is usually reported for cases where slices have low self weight and a relatively high "c" shear strength parameter. In such cases, this effect can only be eliminated by reducing the "c" value.

USER SELECTED option to maintain strength greater than zero

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface
is specified by 15 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	507.07	61.28
2	492.33	58.48
3	477.40	57.06
4	462.40	57.02
5	447.46	58.37
6	432.71	61.10
7	418.28	65.18
8	404.29	70.58
9	390.85	77.25
10	378.09	85.14
11	366.12	94.17
12	355.03	104.28
13	344.93	115.36
14	335.89	127.34
15	333.53	131.15

**** Simplified BISHOP FOS = 1.620 ****

The following is a summary of the TEN most critical surfaces

Problem Description : Maplewood Bioreactor Phase 2

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.620	469.50	218.76	161.90	507.07	333.53	3.143E+07
2.	1.658	465.09	212.63	155.68	505.05	332.63	3.146E+07
3.	1.669	504.10	272.90	214.05	519.19	343.35	2.896E+07
4.	1.671	491.93	286.23	228.11	517.17	325.14	4.369E+07
5.	1.695	520.57	363.64	305.69	535.35	322.86	5.168E+07
6.	1.732	484.83	217.43	158.90	509.09	353.02	2.274E+07
7.	1.753	451.12	175.49	118.97	496.97	340.81	2.378E+07
8.	1.753	506.43	340.01	282.23	529.29	317.63	5.696E+07
9.	1.757	528.85	310.35	253.00	543.43	352.50	2.625E+07
10.	1.767	494.99	284.96	222.05	503.03	334.94	3.290E+07

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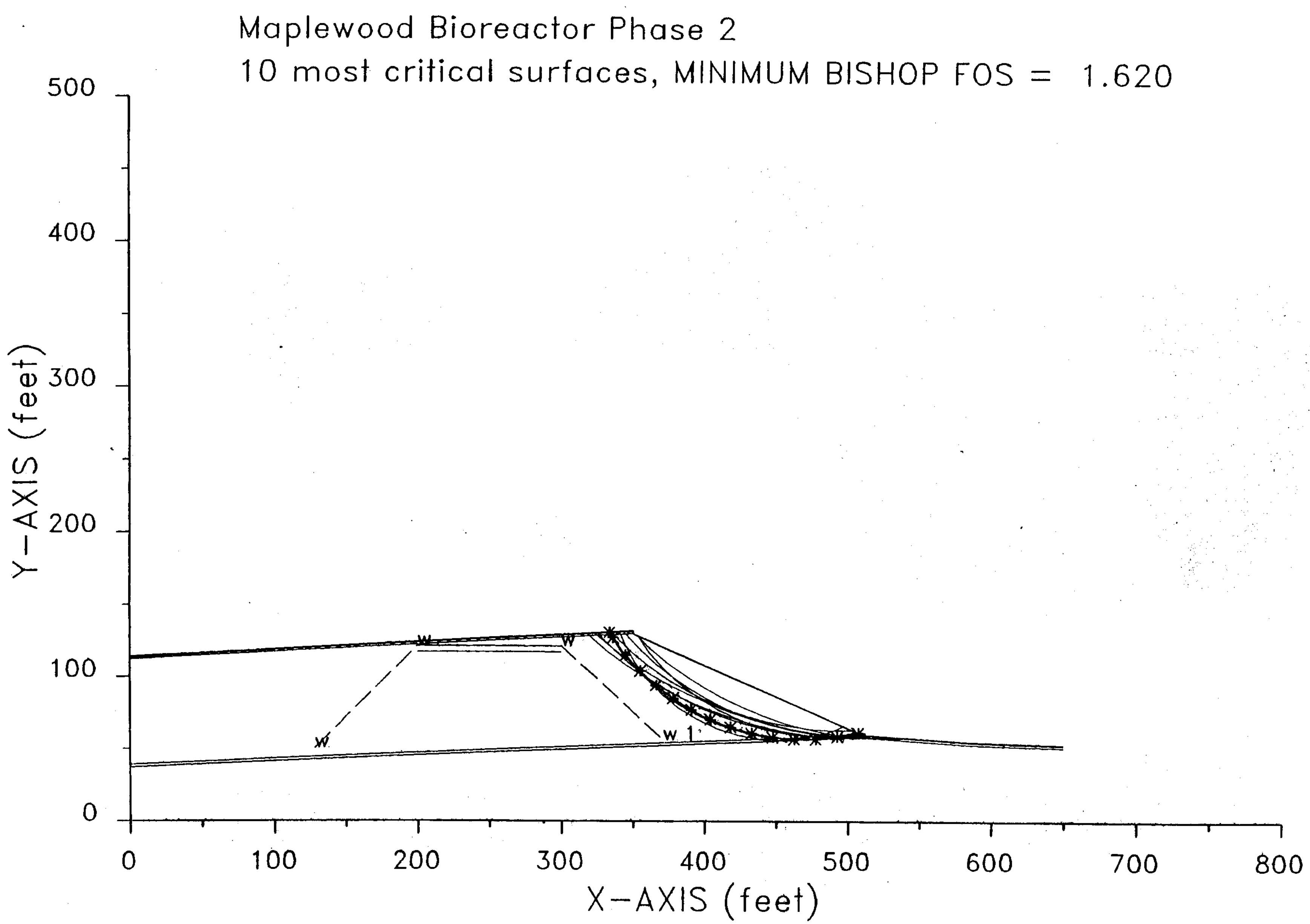
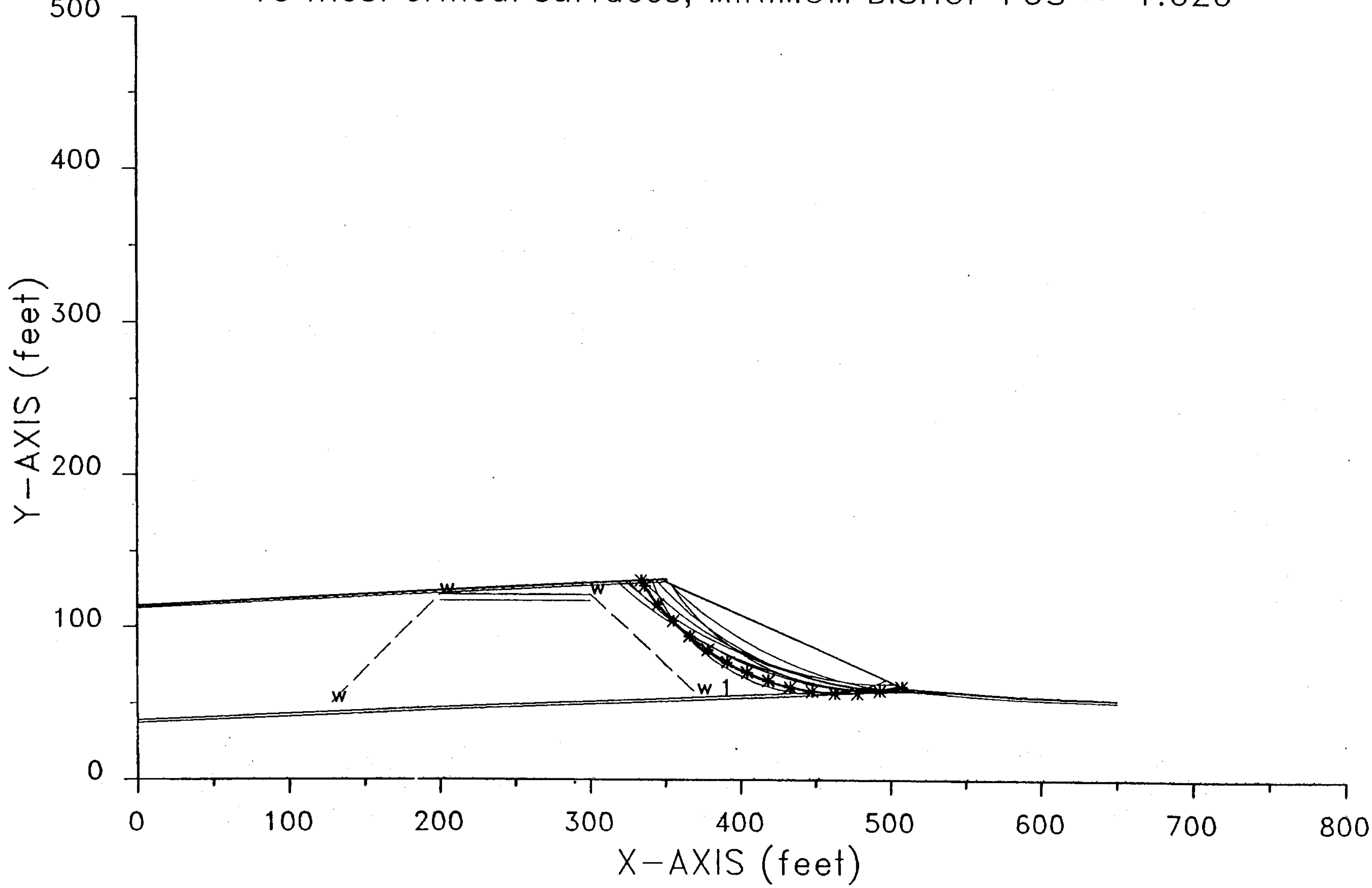


PHAS ' 1-15-** 15:48

Maplewood Bioreactor Phase 2

10 most critical surfaces, MINIMUM BISHOP FOS = 1.620



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*              using the                  *
*          Method of Slices               *
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*******************************************
```

Problem Description : Maplewood Bioreactor Phase 2

SEGMENT BOUNDARY COORDINATES

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	114.0	350.0	132.0	1
2	350.0	132.0	350.1	130.0	1
3	350.1	130.0	510.0	60.0	1
4	510.0	60.0	585.0	55.0	1
5	585.0	55.0	650.0	53.0	1

10 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	112.5	350.0	130.0	2
2	350.0	130.0	510.0	60.0	2
3	200.0	121.5	300.0	121.5	5
4	200.0	117.5	300.0	117.5	2
5	.0	39.0	510.0	60.0	3
6	510.0	60.0	585.0	55.0	3
7	585.0	55.0	650.0	53.0	3
8	.0	37.0	510.0	58.0	4
9	510.0	58.0	585.0	53.0	4
10	585.0	53.0	650.0	51.0	4

ISOTROPIC Soil Parameters

5 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	130.0	130.0	500.0	15.00	.000	.0	0
2	80.0	80.0	.0	.00	.000	.0	1
3	125.0	125.0	.0	10.00	.000	.0	0
4	110.0	110.0	950.0	25.00	.000	.0	0
5	120.0	120.0	.0	30.00	.000	.0	1

NON-LINEAR MOHR-COULOMB envelope has been specified for 1 soil(s)

Soil Unit # 2

Point No.	Normal Stress (psf)	Shear Stress (psf)
1	.0	500.0
2	770.0	500.0
3	25000.0	16235.0

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 4 coordinate points

```
**********************************
        PHREATIC SURFACE,
**********************************
```

Point No.	x-water (ft)	y-water (ft)
1	128.50	50.00
2	200.00	121.50
3	300.00	121.50
4	371.50	56.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

10 Surfaces initiate from each of 100 points equally spaced along the ground surface between x = 400.0 ft and x = 600.0 ft

Each surface terminates between x = 300.0 ft and x = 375.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

****
-- WARNING -- WARNING -- WARNING -- WARNING -- (# 48)
****
Negative effective stresses were calculated at the base of a slice. This warning is usually reported for cases where slices have low self weight and a relatively high "c" shear strength parameter. In such cases, this effect can only be eliminated by reducing the "c" value.
****

USER SELECTED option to maintain strength greater than zero

Factors of safety have been calculated by the : .

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 15 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	507.07	61.28
2	492.33	58.48
3	477.40	57.06
4	462.40	57.02
5	447.46	58.37
6	432.71	61.10
7	418.28	65.18
8	404.29	70.58
9	390.85	77.25
10	378.09	85.14
11	366.12	94.17
12	355.03	104.28
13	344.93	115.36
14	335.89	127.34
15	333.53	131.15

**** Simplified BISHOP FOS = 1.620 ****

The following is a summary of the TEN most critical surfaces

Problem Description : Maplewood Bioreactor Phase 2

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.620	469.50	218.76	161.90	507.07	333.53	3.143E+07
2.	1.658	465.09	212.63	155.68	505.05	332.63	3.146E+07
3.	1.669	504.10	272.90	214.05	519.19	343.35	2.896E+07
4.	1.671	491.93	286.23	228.11	517.17	325.14	4.369E+07
5.	1.695	520.57	363.64	305.69	535.35	322.86	5.168E+07
6.	1.732	484.83	217.43	158.90	509.09	353.02	2.274E+07
7.	1.753	451.12	175.49	118.97	496.97	340.81	2.378E+07
8.	1.753	506.43	340.01	282.23	529.29	317.63	5.696E+07
9.	1.757	528.85	310.35	253.00	543.43	352.50	2.625E+07
10.	1.767	494.99	284.96	222.05	503.03	334.94	3.290E+07

* * * END OF FILE * * *

Written by: Doug Mandeville Date: 1/15/01 Reviewed by: Bill Steier Date: 1/15/01

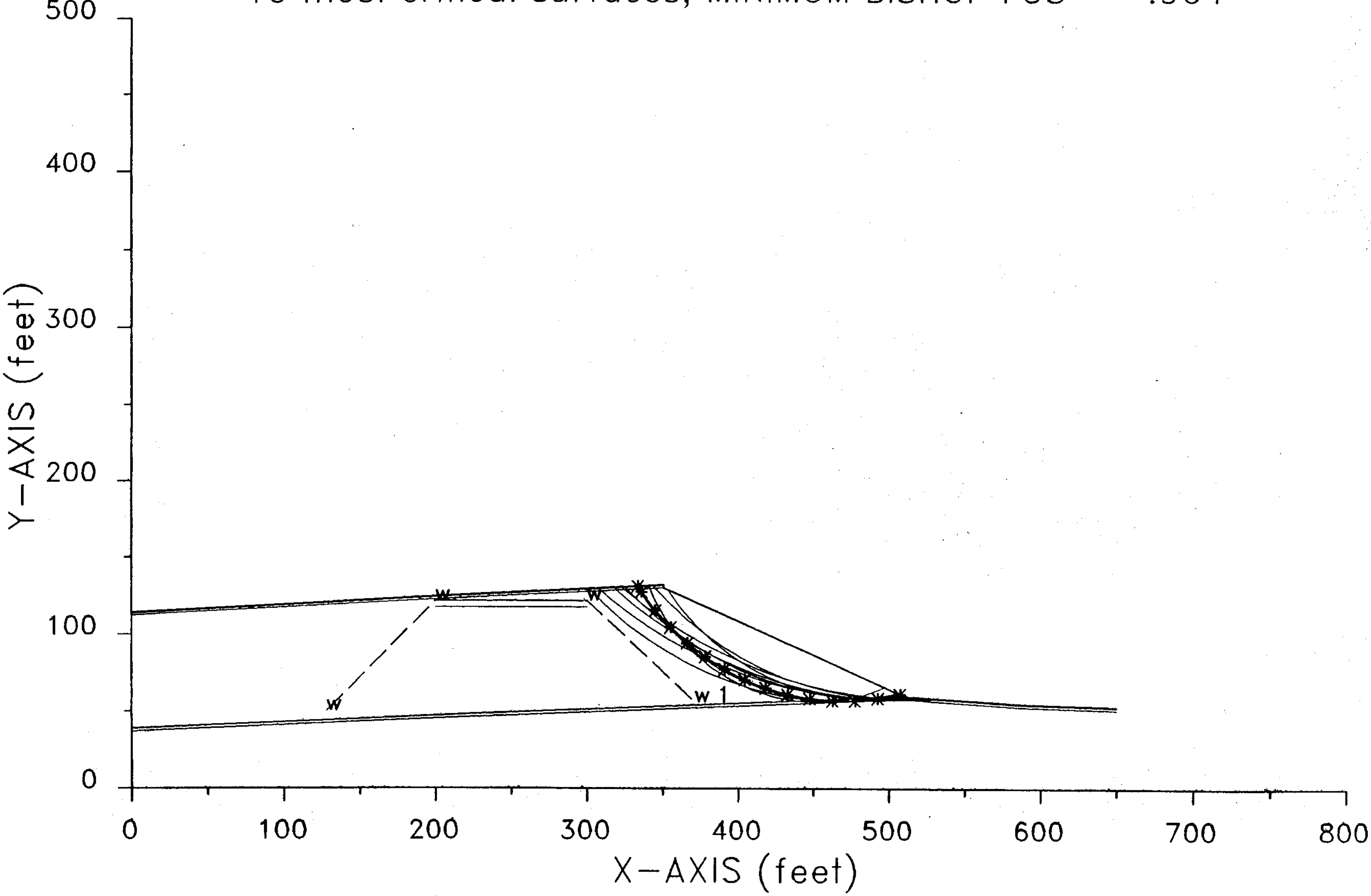
Client: WM Project: Maplewood XL Proj./Proposal No.: ME0169 Task No.: 05

ATTACHMENT B

PHA. .2PE 2-08-** 10:44

Maplewood Bioreactor Phase 2

10 most critical surfaces, MINIMUM BISHOP FOS = .964



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*                                           *
*  Ver. 5.202                  96 - 1305    *
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Problem Description : Maplewood Bioreactor Phase 2

SEGMENT BOUNDARY COORDINATES

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	114.0	350.0	132.0	1
2	350.0	132.0	350.1	130.0	1
3	350.1	130.0	510.0	60.0	1
4	510.0	60.0	585.0	55.0	1
5	585.0	55.0	650.0	53.0	1

10 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	112.5	350.0	130.0	2
2	350.0	130.0	510.0	60.0	2
3	200.0	121.5	300.0	121.5	5
4	200.0	117.5	300.0	117.5	2
5	.0	39.0	510.0	60.0	3
6	510.0	60.0	585.0	55.0	3
7	585.0	55.0	650.0	53.0	3
8	.0	37.0	510.0	58.0	4
9	510.0	58.0	585.0	53.0	4
10	585.0	53.0	650.0	51.0	4

ISOTROPIC Soil Parameters

5 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	130.0	130.0	500.0	15.00	.000	.0	0
2	80.0	80.0	.0	.00	.000	.0	1
3	125.0	125.0	.0	10.00	.000	.0	0
4	110.0	110.0	950.0	25.00	.000	.0	0
5	120.0	120.0	.0	30.00	.000	.0	1

NON-LINEAR MOHR-COULOMB envelope has been specified for 1 soil(s)

Soil Unit # 2

Point No.	Normal Stress (psf)	Shear Stress (psf)
1	.0	500.0
2	770.0	500.0
3	25000.0	16235.0

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 4 coordinate points

```
**********************************
       PHREATIC SURFACE,
**********************************
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Point No.	x-water (ft)	y-water (ft)
1	128.50	50.00
2	200.00	121.50
3	300.00	121.50
4	371.50	56.00

A horizontal earthquake loading coefficient
of .230 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

10 Surfaces initiate from each of 100 points equally spaced along the ground surface between x = 400.0 ft
and x = 600.0 ft

Each surface terminates between x = 300.0 ft
and x = 375.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

15.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

****
-- WARNING -- WARNING -- WARNING -- WARNING -- (# 48)
****
Negative effective stresses were calculated at the base of a slice. This warning is usually reported for cases where slices have low self weight and a relatively high "c" shear strength parameter. In such cases, this effect can only be eliminated by reducing the "c" value.
****

USER SELECTED option to maintain strength greater than zero

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 15 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	507.07	61.28
2	492.33	58.48
3	477.40	57.06
4	462.40	57.02
5	447.46	58.37
6	432.71	61.10
7	418.28	65.18
8	404.29	70.58
9	390.85	77.25
10	378.09	85.14
11	366.12	94.17
12	355.03	104.28
13	344.93	115.36
14	335.89	127.34
15	333.53	131.15

**** Simplified BISHOP FOS = .964 ****

The following is a summary of the TEN most critical surfaces

Problem Description : Maplewood Bioreactor Phase 2

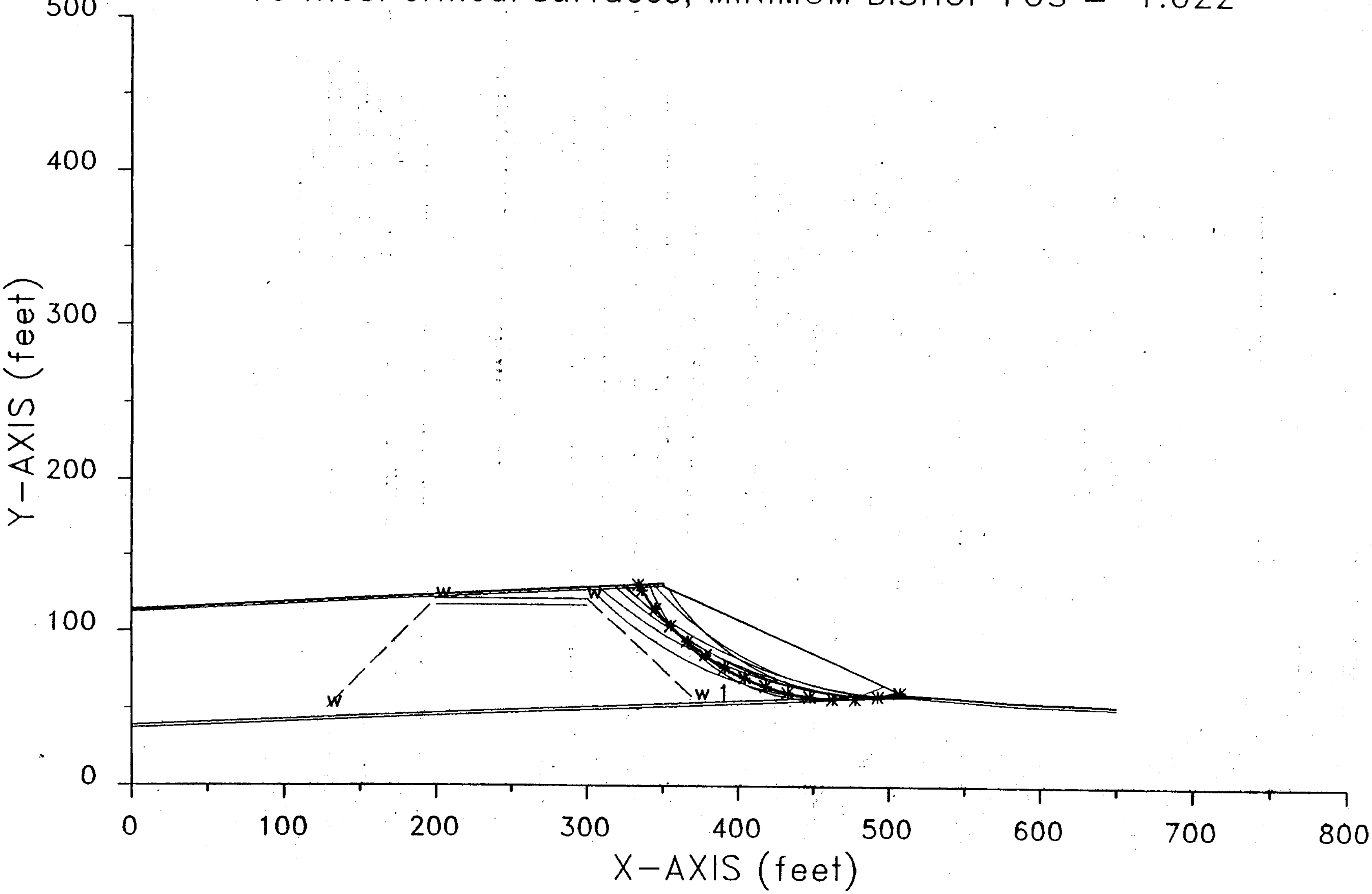
	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	.964	469.50	218.76	161.90	507.07	333.53	2.876E+07
2.	.988	491.93	286.23	228.11	517.17	325.14	4.015E+07
3.	.989	465.09	212.63	155.68	505.05	332.63	2.885E+07
4.	.998	520.57	363.64	305.69	535.35	322.86	4.765E+07
5.	1.018	504.10	272.90	214.05	519.19	343.35	2.696E+07
6.	1.018	471.41	291.73	235.18	511.11	301.30	5.864E+07
7.	1.026	499.74	351.40	293.53	525.25	307.37	6.191E+07
8.	1.028	506.43	340.01	282.23	529.29	317.63	5.269E+07
9.	1.059	484.83	217.43	158.90	509.09	353.02	2.122E+07
10.	1.063	451.12	175.49	118.97	496.97	340.81	2.201E+07

* * * END OF FILE * * *

ATTACHMENT C

PHA: .P1 1-15-** 15:55

Maplewood Bioreactor Phase 2
10 most critical surfaces, MINIMUM BISHOP FOS = 1.022



X S T A B L

Slope Stability Analysis
using the
Method of Slices

Ver. 5.202 96 - 1305

Problem Description : Maplewood Bioreactor Phase 2

SEGMENT BOUNDARY COORDINATES

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
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Soil Unit No.	Unit Weight Moist (pcf)	Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Constant (psf)	Water Surface No.
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2	80.0	80.0	.0	.00	.000	.0	1
3	125.0	125.0	.0	10.00	.000	.0	0
4	110.0	110.0	950.0	25.00	.000	.0	0
5	120.0	120.0	.0	30.00	.000	.0	1

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Water Surface No. 1 specified by 4 coordinate points

PHREATIC SURFACE,

Point No.	x-water (ft)	y-water (ft)
1	128.50	50.00
2	200.00	121.50
3	300.00	121.50
4	371.50	56.00

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A vertical earthquake loading coefficient
of .000 has been assigned

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2.	1.048	465.09	212.63	155.68	505.05	332.63	2.918E+07
3.	1.048	491.93	286.23	228.11	517.17	325.14	4.060E+07
4.	1.059	520.57	363.64	305.69	535.35	322.86	4.817E+07
5.	1.076	504.10	272.90	214.05	519.19	343.35	2.721E+07
6.	1.083	471.41	291.73	235.18	511.11	301.30	5.929E+07
7.	1.090	499.74	351.40	293.53	525.25	307.37	6.255E+07
8.	1.091	506.43	340.01	282.23	529.29	317.63	5.323E+07
9.	1.119	484.83	217.43	158.90	509.09	353.02	2.141E+07
10.	1.124	451.12	175.49	118.97	496.97	340.81	2.222E+07

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